

# PAINT BINDER (TACK COAT) GUIDELINES

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The guidelines are intended for Caltrans Design and Construction personnel. The guidelines address the need to apply a tack coat to all surfaces before paving with Asphalt Concrete (AC), some of the more confusing issues related to tack coats, the upcoming specification changes, and spread rates for rapid-setting emulsion and paving asphalt. These guidelines do not address the chemistry of tack coat materials, storing and handling procedures, materials testing performed by Materials Engineering and Testing Services (METS), or construction equipment.

## TACK COAT MATERIALS

A tack coat is a very light application of asphaltic emulsion or paving asphalt on an existing pavement surface. A tack coat is used to ensure a good bond between the existing pavement surface and the new AC overlay and between the layers of each lift of AC as well as vertical surfaces that the new pavement will be placed against.

### Asphaltic Emulsion

Emulsion consists of three basic ingredients: paving asphalt, water, and emulsifying agent. At times, other additives, e.g., polymers, are added. Polymers are either pre-blended with asphalt prior to emulsification or added as latex. Whenever the term emulsion is used in these guidelines, it is intended to mean asphaltic emulsion.

#### Essential Emulsion Terminology

- **Original emulsion** – An emulsion of paving asphalt and water that contains a small amount of emulsifying agent. Original slow-setting grade emulsions contain up to 43 percent water and original rapid-setting grade emulsions contain up to 35 percent water.
- **Diluted emulsion** – An original emulsion that has been diluted by adding an amount of water equal to or less than the total volume of original emulsion.
- **Residual asphalt content** – The amount of paving asphalt remaining on the pavement surface after the emulsion has broken and cured (after all water has evaporated).
- **Tack Coat Break** – Water separates from the emulsion and the color of the tack coat changes from brown to black

Emulsions shall conform to the requirements in Section 94, “Asphaltic Emulsion,” of the Standard Specifications. The most common types of emulsions used for tack coats include slow-setting grades and rapid-setting grades.

**Slow-Setting Grades** – Slow-setting grades of emulsion used for tack coats are SS1, SS1h, CSS1, and CSS1h. The original slow-setting emulsion, already containing a maximum of 43 percent water, is always diluted by adding up to an equal amount of water. In general, the dilution rate is less when it is cool or damp.

**Rapid-Setting Grades** – Rapid-setting grades of emulsion, which include polymer modified emulsions, used for tack coats are RS1, RS2, CRS1, CRS2, PMRS2, PMRS2h, PMCRS2, and PMCRS2h. The letters “PM” in the rapid-setting grade emulsions denotes polymer-modified emulsion. The rapid-setting emulsions, already containing a maximum of 35 percent water, shall NOT be diluted with additional water.

**Cationic versus Anionic** - The letter “C” in the emulsion type denotes cationic (positively charged) emulsified asphalt particles. The absence of the “C” denotes anionic (negatively charged) emulsified asphalt particles. For example, SS1 is anionic and CSS1 is cationic. The type of emulsifying agent used in the asphaltic emulsion determines if the emulsion will be cationic or anionic. The principal difference in the two is that cationic emulsions give up their water faster. Anionic emulsions carry a negative charge whereas cationic ones carry a positive charge and by theory are best used with aggregates carrying an opposite charge.

Cationic and Anionic are not to be used together. Either cationic or anionic asphaltic emulsion should be used for tack coats. Note that most emulsion manufacturers may not stock all grades of emulsion.

## **PAVING ASPHALT**

The principle source of paving asphalt is the refining of crude petroleum. Paving asphalt shall conform to the requirements in Section 92, “Asphalts,” of the *Standard Specifications*. Paving asphalts, unlike emulsions, paving asphalt carries no charge (i.e. nonionic). Any grade of paving asphalt is acceptable as tack coat material. It would be best to use the same grade of paving asphalt that is included in the asphalt concrete mix.

## **TYPE OF TACK COAT MATERIAL**

Any of the emulsions or paving asphalt mentioned above that conforms to the Standard Specifications can be used for a tack coat. However, local experience and engineering judgment may dictate which type of material is ultimately used. For consideration, the following information and experience is offered for each material type.

Slow-setting emulsions are most commonly used. However, they take longer to break than rapid-setting emulsions. For this reason, they are not recommended for use as a tack coat in relatively cool weather, at night, or when there is a short construction window. The rate of breaking is dependent upon type of emulsion, the amount of water added, the type and concentration of the emulsifying agent, and atmospheric conditions. Cationic emulsions should be used in areas with damp pavement, e.g., coastal areas, because they are less sensitive to moisture and temperature.

Rapid-setting emulsions should be considered for use at night or in cooler weather as their break time is quicker than slow-setting emulsions. Polymer modified rapid-setting emulsions should be considered when placing AC using Performance Based Asphalt (PBA) because the polymer modified emulsion may provide a better bond. However, it is important to note that polymer modified emulsions may be difficult to apply at relatively low spread rates.

Paving asphalt is used for night work or work in cool weather because paving asphalt does not require any time to break before it can be overlaid. Paving asphalt is commonly used as a tack coat material for new rubberized AC (RAC) overlays. Paving asphalt is heated and applied at a much higher temperature than an emulsion. Paving asphalt can be specified as the tack coat in the contract, and can be used at the option of the contractor or ordered by the resident engineer. If the engineer orders its use, the contractor will be paid the differential between the cost of the emulsion and the paving asphalt.

## **TACK COAT APPLICATION**

### **ESTIMATING THE AMOUNT OF TACK COAT AND APPLICATION RATE**

It is important to estimate the amount of tack coat to be used as accurately as possible. The tack coat application rate varies with the condition of the existing surface to which it is applied. In general, a tight or dense surface requires less tack coat than an open textured, raveled, or milled surface, and a flushed or bleeding surface requires less tack coat than a dry or aged surface. The proper application rate also varies with the type of tack coat material used and the asphalt concrete that will be placed as an overlay. Slow-setting grade emulsions will require higher application rates than rapid setting grade emulsions, and rapid-setting grade emulsions will require a higher application rate than paving asphalt (note that the residual asphalt content will be about the same). Dense and gap-graded AC overlays require less tack coat than open-graded AC overlays.

For design purposes, the designer should use Table 1 to determine application rates. If the designer is not familiar with the condition of the surface, then the designer should use an application rate which is in the middle of the range shown in Table 1 below for the road surface type and the type of tack coat to be used. District maintenance or construction may provide appropriate application rates for estimating quantities. Use the table in *Standard Specification* section 39-6.01 or the Standard Special Provisions (SSP) to be used on your project to determine the number of layers to be used for the thickness of the AC on each project.

### **SAMPLING AND TESTING TACK COAT MATERIALS**

Obtain the required test report and certificate of compliance from each truckload of emulsion or paving asphalt before the application of tack coat starts. Compare the report with the specifications. Shipments may be used prior to sampling and testing if certificates of compliance and the test results accompanying them on the test report conform to the specifications. However, for rapid-setting emulsions, samples of the base asphalt must be submitted to Materials Engineering and Testing Services, (METS) at least 10 working days prior to beginning work if the contractor elects to use the test for polymer content (CT 401) in lieu of torsional recovery (CT 332) for measuring polymer content (see Section 94-1.03 of the *Standard Specifications*).

During construction, samples of tack coat materials are taken by construction personnel and sent to METS for testing as detailed in Table 2 and Table 3. Shipments of samples need to be expedited because of the long turn around time on testing. Requirements for sampling and testing emulsion and paving asphalt are provided in Table 6-1.6 of Chapter 6 of the *Construction Manual (manual)*. Details for sampling emulsion and paving asphalt submitted with certificates of compliance are included in Section 6-202E in Chapter 6 of the manual. Details for sampling emulsion and paving asphalt are included in California Test 125, "Methods for Sampling Highway Materials and Products Used in the Roadway Structural Sections."

**Table 1- Paint Binder (Tack Coat) Application Rates**

Asphalt Concrete overlay ( <b>except Open Graded</b> ) Liters per square meter			
Type of Surface to be Tack Coated	Slow-Setting Asphaltic Emulsion	Rapid-Setting Asphaltic Emulsion	Paving Asphalt
Dense, Tight Surface (e.g., between lifts)	0.20 – 0.35 <sup>A</sup>	0.10 – 0.20 <sup>B</sup>	0.05 – 0.10
Open Textured or Dry, Aged Surface (e.g., milled surface)	0.35 – 0.90 <sup>A</sup>	0.20 – 0.40 <sup>B</sup>	0.10 – 0.25
Open-Graded Asphalt Concrete overlay Liters per square meter			
Type of Surface to be Tack Coated	Slow-Setting Asphaltic Emulsion	Rapid-Setting Asphaltic Emulsion	Paving Asphalt
Dense, Tight Surface (e.g., between lifts)	0.25 – 0.50 <sup>A</sup>	0.10 – 0.25 <sup>B</sup>	0.05 – 0.15
Open Textured or Dry, Aged Surface (e.g., milled surface)	0.50 – 1.10 <sup>A</sup>	0.25 – 0.55 <sup>B</sup>	0.15 – 0.30

<sup>A</sup>Asphaltic emulsion diluted with additional water. The water shall be added and mixed with the asphaltic emulsion (which contains up to 43 percent water) so that the resulting mixture will contain one part asphaltic emulsion and not more than one part added water. The water shall be added by the emulsion producer or at a facility that has the capability to mix or agitate the combined blend.

<sup>B</sup> Undiluted Asphaltic Emulsion.

**Table 2 - General Sampling Details**

- Samples of emulsion shall be taken in conformance with the requirements in American Association of State Highway and Transportation Officials (AASHTO) Designation: T40, "Sampling Bituminous Materials," Chapter 6 of the *Construction Manual (manual)* and California Test 125.
- Samples of paving asphalt shall be taken in conformance with Chapter 6 of the *manual*, and California Test 125.
- Observe safety procedures. The boot truck driver usually does the sampling in the presence of the engineer.
- Sample each shipment of emulsion using new, clean, dry 2-L plastic jugs.
- Sample paving asphalt daily using new, clean, dry 1 L Cans with Screw Lids.
- Samples are normally taken from the spray bar at the rear of the distributor. Drain off sufficient material through the nozzle to ensure removal of any material lodged there.
- Samples should be taken after one-third and not more than two-thirds of the load has been removed.
- Do not submerge sample containers in solvent or wipe containers with solvent saturated cloth. Use a dry clean cloth only immediately after sampling to clean containers.
- Attach a Sample Identification Form (TL-0101) to each material sample in accordance with chapter 6 of the manual and instructions printed on the TL-0101 booklet. Protect the TL-0101 against moisture and stains.
- Provide the e-mail address of the resident engineer on the TL-0101.
- Provide the original emulsion dilution rate, if applicable, on the TL-0101 (some test results are meaningless if the dilution rate is unknown).
- Rapid-setting asphaltic emulsion has a shelf life. It is important that all samples be sent to METS daily.
- Store all samples in a cool environment and do not allow samples to roll around or to be shaken during transportation

**Table 3- General Testing Details**

- Send samples by commercial parcel delivery for testing to METS:  
Materials Engineering and Testing Services  
Office of Flexible Pavement Materials, MS #5  
5900 Folsom Boulevard  
Sacramento, California 95819-4612
- Samples are not to be shipped C.O.D.
- Paving asphalt will be tested for compliance with Section 92, "Asphalts," of the *Standard Specifications*.
- Emulsion will be tested for compliance with Section 94, "Asphaltic Emulsions," of the *Standard Specifications*.
- Test results are mailed to resident engineers. To expedite return of test results, test cards can be e-mailed or faxed to resident engineers if an address or phone number is provided on the TL-0101. Failing test results are faxed or phoned in to the resident engineer the same day the test is conducted.

## MEASUREMENT AND PAYMENT

Emulsion and paving asphalt are measured for payment by mass. The unit of mass is the tonne.

Construction personnel are to collect initial load slips or weight certificates from each load of emulsion or paving asphalt and, if partial loads were used, personnel should collect weigh-back slips or certificates to determine pay quantities. Construction personnel will sign or initial all load slips or weight certificates to indicate that the material represented thereon was incorporated in the work.

When partial loads of emulsion or paving asphalt are used for tack coat and no scales are located within 35 km of the job site, then the mass of emulsion and paving asphalt remaining on the distributor can be determined from volumetric measurements. The unit of volume is the liter. To determine the volume of material used, stab the tank after spreading or read the vehicle tank meter, and determine the temperature of the remaining material. It is important to record the temperature of the material to be able to convert the volume of the material at any other temperature to the volume it would occupy at 15°C. The volume of the emulsion or paving asphalt at 15°C is then converted to mass. (See requirements in Sections 92-1.05 or 94-1.07 of the *Standard Specifications*).

**Example 1a:** Suppose a partial load of slow-setting emulsion was used for a tack coat and no scales are located within 35 km of the jobsite. The difference in the vehicle tank meter before and after spreading the tack coat is 500 liters (verify amount placed is less than tank capacity). The temperature of the emulsion was 50°C.

From the Conversion Table in Section 94-1.07 of the *Standard Specifications*, it is determined that the multiplier for converting the volume of the emulsion at 50°C to the volume it would occupy at 15°C is 0.984 50. Therefore, the volume of emulsion used was 492.25 liters. (500 liters x 0.984 50). The density of emulsion at 15°C is 1002 liters per tonne (see Section 94-1.07). Therefore, the weight of the emulsion used was 0.49 tonnes, calculated as 492.25 liters ÷ 1002 liters per tonne. However, because the slow-setting emulsion was diluted 1:1 with water and no payment is allowed for the additional water, the final pay quantity is 0.25 tonnes, (0.49 tonnes x 0.50 emulsion to water ratio.)

It is important to note that payment is made for the original emulsion, not for the diluted emulsion. Do not pay for water that has been added to the emulsion. This applies to slow-setting grades of emulsion only since other tack coat materials are not diluted with additional water.

**Example 1b:** Suppose a partial load of slow-setting emulsion was used for a tack coat and there were scales located within 35 km of the job site, then the weigh-back slips or weight certificates would have shown directly that approximately 0.49 tonnes of emulsion was spread. However, do not forget the emulsion was diluted 1:1 with additional water and so the pay quantity will still be 0.25 tonnes.

**Example 1c:** Suppose a rapid-setting emulsion was used for tack coat, then the final pay quantity would have been 0.49 tonnes. This is because the rapid-setting emulsion is NOT diluted with additional water.

**Example 2:** Suppose a partial load of AR-4000 paving asphalt was used for a tack coat and no scales are located within 35 km of the jobsite. The difference in the vehicle tank meter before and after spreading the tack coat is 500 liters (verify amount placed is less than tank capacity). The temperature of the asphalt was 160°C (paving asphalt is applied at a much higher temperature than an emulsion).

It is determined from Section 92-1.05 of the Standard Specifications that the density of AR-4000 at 15°C is 981 liters per tonne or 1020 kg/m<sup>3</sup>. According to the Conversion Table in Section 93-1.04, the “A” multiplier (as opposed to the “B” multiplier) is used for reducing volumes of asphalt that have a density greater than 966 kg/m<sup>3</sup> to the volume it would occupy at 15°C. The “A” multiplier at 160°C is 0.9118. Therefore, the volume of paving asphalt used was 455.9 liters (500 liters x 0.9118). The density of paving asphalt at 15°C is 981 liters per tonne (see Section 92-1.05). Therefore, the mass of the asphalt used was 0.46 tonnes (455.9 liters ÷ 981 liters per tonne). Because paving asphalts are not diluted with water, the final pay quantity is 0.46 tonnes.

## **TACK COATS FOR BITUMINOUS SEALS**

The preceding discussion dealt with tack coats for overlays. This section deals with tack coats and bituminous seals.

A tack coat is not required prior to placing a chip seal. However, a chip seal may receive a flush coat (fog seal and sand cover) on its surface.

Tack coat should not be applied to a Stress Absorbing Membrane Interlayer (SAMI) unless a flush coat (fog seal plus sand cover) was placed on the SAMI. A SAMI provides an excellent bond to an AC overlay, but the sand from the flush coat can break the bond.

A tack coat is not generally required prior to a slurry seal or a micro-surfacing application unless the existing pavement surface is extremely dry and raveled or is Portland cement concrete. If required, a slow-setting grade of emulsion mixed in proportion of one part of original emulsion to three parts additional water should be used. The application rate is to be between 0.4 L/m<sup>2</sup> and 0.7 L/m<sup>2</sup>. The tack coat must cure before applying the slurry seal or micro-surfacing. Slow-setting emulsions should conform to the requirements above for overlays, including sampling, testing, measurement and payment, etc.

### **Placement Considerations for Tack Coats**

When tack coat is applied, use the following check list to ensure a proper placement:

- ❑ **A test spread** should be done. Work with the distributor truck driver.
- ❑ **Placement rates** are dependent upon pump rates and speed of the distributor truck.
- ❑ **Uniformity of application** is very important. The height of the spray bar should be set high enough above the roadway for the surface to receive double coverage.
- ❑ **Streaking and puddling**, two extremes of application are indications of inappropriate spread rates or of improper height of the spray bar.
- ❑ **A surface free of substances** that will inhibit bond is critical. A dirty or dusty surface will inhibit the ability of the tack coat to bond potentially resulting in a slippage plane. A fine dust coating can occur overnight.
- ❑ **Excessive tack coat** is detrimental as it acts as a lubricant creating a slip plane. Excessive tack coat should be blotted by applying sand, and by the use of a pneumatic-tired roller.
- ❑ **For safety** reasons traffic should be kept off a tack coat surface. If traffic must use the surface apply a sand cover

- ❑ **The tack coat may become slick** if it rains on a newly placed tack coat. It is prudent to have a source of sand available for these situations.
- ❑ **If sand is applied to the tack coat**, the pavement will have to be swept, or flushed with water, to remove the sand and the tack coat will have to be reapplied before resuming paving operations.
- ❑ **Ensure the tack coat emulsion has broken** (changed color from brown to black) before paving. As a rule of thumb, if the tack coat sticks to the bottom of your boot, e.g., you have difficulty lifting the heel, it is ready to be paved over.
- ❑ **Verify bond** to existing pavement surface and between layers by checking cores. to determine if the tack coat has securely bonded to the existing surface and between layers. A smooth bottom of a core is evidence the tack coat has not bonded to a layer.

### **Where to apply Tack Coats**

- Tack coat is always applied between pavement lifts, unless specified or directed by the engineer
- Tack coat should be applied only to an area that can be covered by the same day's paving
- Tack coat is to be applied to all vertical surfaces of existing pavement, curbs, gutters and construction joints where new overlay will be placed
- Tack coat is applied to other surfaces designated in the special provisions

### **Where NOT to apply Tack Coats**

- Tack coat should not be applied to an area that cannot be covered by the same day's paving
- Tack coat should not be applied to a Pavement Reinforcing Fabric (PRF). PRF is already saturated with paving asphalt
- Tack coat should not be applied to a Stress Absorbing Membrane Interlayer (SAMI) unless a flush coat (fog seal plus sand cover) was placed on the SAMI. A SAMI provides an excellent bond to an AC overlay, but the sand from the flush coat can break the bond
- Tack coat should not be applied to a bleeding surface
- Tack coats are not applied to untreated bases. They receive an application of prime coat.